REMARKS

Claims 10-27 are pending in this application. By this Amendment, the Abstract is amended and claim 28 is canceled without prejudice to, or disclaimer of, the subject matter recited in that claim. No new matter is added. Reconsideration of the application based on the above amendments and the following remarks is respectfully requested.

Applicant voluntarily amends the title to "A Method For Producing A Single Crystal" instead of "A Method For Producing A Single Crystal And A Single Crystal" because product claim 28, reciting a single crystal, is canceled.

The Office Action, on page 2, objects to the Abstract because it allegedly exceeds 150 words. The Abstract is amended by the attached amended Abstract to obviate this objection. Withdrawal of this objection is respectfully requested.

The Office Action, on page 2, rejects claim 28 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 6,334,896 to Iida et al. ("Iida"). Without conceding the propriety of the rejection and simply to advance prosecution, claim 28 is canceled. Therefore, the rejection of claim 28 is rendered moot.

The Office Action, on page 4, rejects claim 10-28 under 35 U.S.C. §103(a) as being unpatentable over Iida in view of U.S. Patent No. 5,685,907 to Fujikawa et al. ("Fujikawa"). This rejection is respectfully traversed.

Claim 10 recites, among other features, that a pulling rate of pulling a single crystal is defined as V (mm/min), a temperature gradient at a solid-liquid interface is defined as G (K/mm) and a highest temperature at an interface between a crucible and a raw material melt is defined as Tmax (°C), at least, a range of a value of V/G ($mm^2/K \cdot min$) including a desired defect region and/or a desired defect-free region is determined according to the Tmax (°C). At least these features of claim 10 cannot reasonably be considered to be taught, or to have been suggested, by Iida.

Iida teaches, at col. 3, lines 1-14 how a value of V/G influences the spatial distribution of the Vacancy Rich region (V-rich region), the Neutral Region (N-region), the Interstitial Silicon Rich Region (I-rich region) and the ring-shaped Oxidation Induced Stacking Fault region (OSF ring). For example, if the value of V/G is selected to be $0.1mm^2/(°C \cdot min)$, the single crystal becomes an I-rich region from 0 to approximately 78mm and becomes an N-region from approximately 78-80mm. In the pulling process in Iida, silicon is cooled from 900°C to 600°C within 700 minutes.

Therefore, Iida teaches that a single crystal is pulled with a value of V/G that is controlled to be a specific value. Iida fails to teach pulling a seed crystal from a raw material melt, wherein when a pulling rate of pulling a single crystal is defined as V (mm/min), a temperature gradient at a solid-liquid interface is defined as G (K/mm) and a highest temperature at an interface between a crucible and a raw material melt is defined as Tmax (°C), at least, a range of a value of V/G ($mm^2/K \cdot min$) including a desired defect region and/or a desired defect-free region is determined according to the Tmax (°C), as positively recited in claim 10. Moreover, as conceded in the Office Action on page 5, lines 16-18, Iida fails to teach that a highest temperature at an interface between a crucible and a raw material melt is a result-effective variable in producing a defect or a defect-free region in the pulled crystal.

The Office Action relies on Fujikawa for allegedly curing the deficiencies of Iida. This assertion is incorrect for at least the following reasons (1) Fujikawa cannot reasonably be considered to teach the features that the Office Action attributes to this reference; and (2) Fujikawa is not combinable with Iida in the manner suggested.

The Office Action, on top of page 6, asserts that Fujikawa teaches at col. 10, lines 35-42, features that can reasonably be considered to correspond to a defect region or a defect-free region is determined according to the Tmax (°C). This assertion is incorrect.

Fujikawa teaches, at col. 10, lines 36-42, that a zinc selenide single crystal is formed in the zinc blende structure by performing supercooling of the melt from 1520°C to below 1425°C to prevent forming zinc selenide in the wurtzite structure. Fujikawa further teaches that keeping solidified zinc selenide at 1400°C allows avoiding transformations and variations in composition in the production of zinc selenide single crystals in the zinc blende structure.

Accordingly, Fujikawa teaches that zinc selenide source material is melted by the ring shaped heater elements and subsequently subjected to the supercooling by changing the thermal distribution of the ring shaped heater elements such that the source material is solidified from the bottom to the top of the crucible. During this process, portions of the source material are subsequently cooled.

Further, as evidenced by col. 10, lines 27-29, of Fujikawa, the solidifying temperatures referred to in that reference are the temperatures of the portion of the source material melt in contact with the seed crystal and not the temperatures of the portion of the source material melt and the source material container.

Therefore, contrary to the assertions in the Office Action, the teaching in Fujikawa of changing the heat distribution of ring shaped heaters to cool a melt from bottom to the top of a crucible taking into consideration the temperature at a portion between the growing crystal and the source material melt cannot reasonably be considered to correspond to a pulling rate of pulling a single crystal is defined as V (mm/min), a temperature gradient at a solid-liquid interface is defined as G (K/mm) and a highest temperature at an interface between a crucible and a raw material melt is defined as Tmax (°C), at least, a range of a value of V/G ($mm^2/K \cdot min$) including a desired defect region and/or a desired defect-free region is determined according to the Tmax (°C), as positively recited in claim 10.

Additionally, Iida and Fujikawa are not combinable in the manner suggested. Iida teaches forming a silicon single crystal by the Czochralski method. Fujikawa teaches

producing a compound single crystal by the vertical gradient freeze (VGF) solidifying method. Specifically, Fujikawa teaches, at col. 1, lines 31-41, that the VGF method employs ring-shaped heaters in multiple stages in a furnace to control the form of a temperature distribution to gradually solidify a melt from the bottom of a melt of the compound material in contact with a compound material seed crystal to obtain a single crystal. The VGF method taught in Fujikawa is not combinable in the manner suggested with the Czochralski method taught in Iida because in the Czochralski method a movable seed crystal is pulled from molten silicon, whereas in the VGF method a temperature distribution is changed relative to a stationary seed crystal. Specifically, subjecting a solidified single crystal to a large temperature gradient by varying the temperature distribution of ring-shaped heaters as taught in Fujikawa, is not combinable with the pulling of a single crystal from a silicon melt, as taught in Iida because the suggested combination would require that the seed crystal is simultaneously pulled from the melt and kept at the bottom of the crucible.

Therefore, even if the teachings of Iida and Fujikawa were combined in the manner asserted in the Office Action, the claimed subject matter could not be derived.

For at least the above reasons, Iida and Fujikawa cannot reasonably be considered to teach, or to have suggested, the combinations of all of the features positively recited in at least independent claim 10. Further, claims 11-27 would also not have been suggested by the applied references for at least the respective dependence of these claims on allowable independent claim 10, as well as for the separately patentable subject matter that these claims recite.

Accordingly, reconsideration and withdrawal of the rejection of claims 10-27 under 35 U.S.C. § 103(a) as being unpatentable over the applied references are respectfully requested.

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 10-27 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

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WPB:GMH/gml

Attachment:
Amended Abstract

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